Dryden Flight Research Center
Edwards, California 93523-0273

DHB-P-002
Revision: D

DRYDEN HANDBOOK

CODE P

PROJECT MANAGER'S HANDBOOK

Electronically Approved By:
Director, Aerospace Projects Directorate

DOCUMENT HISTORY PAGE

This page is for informational purposes and does not need to be retained with the document.

DATE APPROVED	ISSUE	PAGE	AMENDMENT DETAILS
3/29/99	Baseline		
6/10/99	Revision A	15-19	Added Chapter Three
8/13/99	Revision B	20-22	Added Chapter Four
4/6/00	Revision C	23-33	Added Chapter Five and figures.
See IDMS Document Master List	Revision D	34-36	Added Chapter Six

INTRODUCTION

Purpose: Provide a reference for Code P Project Managers on various products and tasks associate with implementing the Dryden Research Flight Project Manager function.

Applicability: All projects managed within Code P, the Aerospace Project Directorate.

Concept: The handbook will be comprised of chapters on different subjects. It will be a document that is continually expanded. It will provide background, guidance, and examples.

Approach: Formulate each chapter based on need. Revise the handbook as often as a new chapter of a chapter update is needed.

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CHAPTER 1

A. PROJECT PLAN

A project plan is required for each Research Flight Project managed by Code P. The plan should normally conform with the NPG 7120.5A format.

II. Deviations

There will be situations that make it necessary for the project plan to have a different format. The Director of the Aerospace Projects Directorate/Code P may authorize this deviation.

Also, small projects or experiments may use a reduced format project plan. This approach, too, may be authorized by the Code P Director.

Project Plans should include all of the sections presented in NPG 7120.5A, Deviations must be authorized by the Code P Director and the Program Manager.

III. Approval

The Center Director and Program Manager must approve the Project Plan.

Prior to approval, the Plan is routed to the following single letter codes for review and comment: : A, C, F, J, L, O, P, R, S, and T, using the Code P Routing Sheet and coordinated by the Code P Secretary. The Project Manager must respond to the comments on the routing sheet, whether or not they are incorporated. The routing sheet will be included in the Project File.

Multi-organization projects may need to use a more comprehensive review and approval process. The approach should be briefed to the Dryden Planning Board, and be agreed upon by the Program Manager.

IV. Small Project Plan Approval

The Code P Director may authorize the approach to review and approval of the small project plan. As a minimum, the Code P Director must approve the document, and copies sent to the following single letter codes: A, C, F, J, L, O, P, R, S, and T.

Attachments:
A Description of Contents of Project Plan
B Small Project Plan Sample Format

Chapter 1
Attachment A

CONTENTS OF PROJECT PLAN

PROJECT PLAN

Submitted by:

___________________________________ ___________
Project Manager Date

Approved by:

___________________________________ ___________
Center Director Date

___________________________________ ___________
Program Manager Date

TABLE OF CONTENTS

INTRODUCTION

The project is identified by an officially approved title, NASA program, PCA, and/or unique project number. A brief general history and summary are given, including the project's purpose, goals, overall approach, and timeframe. For multiple NASA
Center projects, describe the NASA Center's project in relationship to the other participating NASA Centers.

OBJECTIVES

State the specific project objectives, performance goals, and performance indicators and their relationship to the program objectives and goals. Performance goals should be expressed in an objective, quantifiable, and measurable form.

CUSTOMER DEFINITION AND ADVOCACY

State the main customers of the project and the process to be used to ensure customer advocacy.

PROJECT AUTHORITY

Identify the Lead Center and supporting Centers responsible for the implementation and the GPMC responsible for the oversight
of the project.

MANAGEMENT

Describe the project management structure, including its integration into the program management structure and NASA Center participation. Identify all significant interfaces with other contributing organizations. Be consistent with the roles and responsibilities prescribed in Appendix D of NPG 7120.5A: Responsibilities for Program and Project Management. Identify specific management tools to support management in planning and controlling the project. Describe the use of special boards and committees. This section should address any requirement for a NASA Resident Office including duties and authority.

a. Organization and responsibilities.
b. Special boards and committees.
c. Management support systems.

TECHNICAL SUMMARY

Project requirements are presented with a technical description of the project. This includes the allocation of these requirements among the systems to be developed (hardware and software), use of the metric system, facilities, flight plans, operations and logistics concepts, and planned mission results analysis and reporting.

a. Project requirements.
b. System(s).
c. System operations concept.
d. System constraints.
e. Ground systems and support.
f. Facilities.
g. Logistics.

h. Mission results analysis and reporting.

SCHEDULES

Document the project's master schedule for all major events and activities planned for the entire project throughout the life cycle of the program. Include approval dates for principal program/project documentation, life-cycle transitions, major reviews, program-controlled milestones, and significant contract milestones. Identify lower level schedules to be developed and maintained.

RESOURCES

a. Funding Requirements. Present a funding requirements chart that includes the same elements as for the acquisition summary. Indicate the NOA in real-year dollars for the prior, current, and remaining fiscal years. The level of detail should be at WBS 2.0
level or its equivalent.

b. Institutional Requirements. Present the institutional requirements for the entire project throughout its life cycle. Include civil service workforce requirements on the providing organizations for the prior (e.g., actuals), current, and remaining years.

CONTROLS

All technical performance, cost, or schedule parameters specified, as requiring approval by the Administrator, the EAA, the LCD, or program manager, should be identified. Examples include funding by year, program requirements, project objectives, PPM structure, and major program/project documentation. Identify the thresholds associated with each parameter which could cause a change request. Describe the process by which project requirements are validated for compliance with program requirements. Describe the process for controlling changes to these requirements. As applicable, for:

a. Administrator.
b. Enterprise Associate Administrator.
c. Lead Center Director.
d. Program Manager.

IMPLEMENTATION APPROACH

The implementation approach of the project is provided (e.g., in-house, NASA Center prime, contractor prime),as well as a project WBS. Summarize and reference appropriate descope plans.
a. Implementation approach.
b. Project summary WBS (recommended to level 3)

ACQUISITION SUMMARY

Provide summary information on procurement items, such as element (engineering design study, hardware development, mission and data operations support); type of procurement (competitive, AO for instruments; type of contract (cost-reimbursable, fixed-price); source (institutional, contractor, other Government organizations); procuring activity (NASA Center); and technical monitoring (NASA Center).

PROJECT DEPENDENCIES

Other NASA, U.S. agency, and international activities, studies, and agreements are summarized with emphasis on their effect on the program.

a. Related activities and studies, e.g., SOMO, Launch Services, crosscutting technology.
b. Related non-NASA activities and studies.

AGREEMENTS

List all agreements necessary for project success and the projected dates of approval. This list shall include all agreements concluded with the authority of the project manager, and should reference agreements concluded with the authority of the Lead Center program manager and above.

a. NASA agreements, e.g., SOMO Service Level Agreements, Launch Services Agreements.
b. Non-NASA agreements.

(1) Domestic.
(2) International.

PERFORMANCE ASSURANCE

For each of the subsections, cite the relevant requirements documents and summarize the way in which they will be followed. The plans and specific procedures should be identified to accomplish the applicable performance assurance items listed in the subsections, as appropriate.

a. General.
b. Reliability.
c. Quality assurance.
d. Parts.
e. Materials and processes control.
f. Performance verification.
g. Contamination allowance and control.
h. Software assurance.
i. Maintainability.

RISK MANAGEMENT

Project Risks should be addressed for the following areas: management, technical, and safety. For each risk identified, provide a description of the risk, probably impact, and planned approach to mitigation.

The Risk Management Planning shall include the following, as appropriate:

a. Introduction. Purpose, scope, assumptions, constraints, and policies pertaining to this plan and the project risk management process.

b. Overview of process. Overview of risk management process and data flow and how it integrates and relates to other project management activities.

c. Organization. Organization, roles, and responsibilities of the project, customer, and suppliers.

d. Process details. Risk management process and related procedures, methods, tools, and metrics for each major function in figures 4-1 and 4-2 of NPG 7120.5A.

e. Resources and schedule. Schedule, milestones, and required resources for risk management activities.

f. Documentation of risks. Describes how risk information is documented (e.g., data base and templates), retained, controlled, and used.

g. Methodology. Describe how the project will apply the program descope methodology deriving the point at which the project is no longer viable.

ENVIRONMENTAL IMPACT

The required Environmental Assessment (EA) and Environmental Impact Statements for the project should be identified with the schedule for their accomplishment.

SAFETY

For each of the subsections, cite the relevant safety requirements documents and summarize the way in which they will be followed. Refer to paragraph 4.5 for requirements on safety planning (e.g., Industrial, Range, and System).

TECHNOLOGY ASSESSMENT

Identify the NASA technology thrusts to be applied. Identify those technologies in the project that will mature during its life cycle.

COMMERCIALIZATION

Identify near-term opportunities for commercialization. Describe the methods to be used to identify additional opportunities throughout the project's life cycle.

REVIEWS & REPORTING

Provide the names, purposes, content, and timing of all reviews shown in SCHEDULES above. Explain the reporting requirements for program and project reviews.

TAILORING

This paragraph should identify the process and requirements which have been revised with supporting rationale in reference to NPG-7120.5A. It identifies the unique approaches to be approved by management.

GLOSSARY AND PROJECT TERMINOLOGY

CHANGE LOG

Changes to the Project Plan should be documented in a change log.

7120.5A Acronyms:

AO	Announcement of Opportunity
EA	Environmental Assessment
EAA	Enterprise Associate Administrator
GPMC	Governing Program Management Council
LCD	Lead Center Director
NPG	NASA Procedures and Guidelines
NOA	New Obligation Authority
PCA	Program Commitment Agreement
PPM	Program/Project Management
SOMO	Space Operations Management Office

Chapter 1
Attachment B

CONTENTS OF SMALL PROJECT PLAN

This format can be used, if authorized by the Director of Code P. The Project Manager will recommend the extent to which these contents are to be applied. This list of contents is intended to indicate the nature of the type of plan that would be appropriate.

SMALL PROJECT PLAN

Submitted by:

___________________________________ ___________

Project Manager Date

Approved by:

___________________________________ ___________

Director Date

Aerospace Projects Office

Concurrence:

___________________________________ ___________

Others, as appropriate Date

INTRODUCTION

OBJECTIVES

CUSTOMERS and PARTNERS

TECHNICAL SUMMARY

Project requirements are presented with a technical description of the project. This includes the allocation of these requirements among the systems to be developed (hardware and software), facilities, flight plans, operations and logistics concepts, and planned mission results analysis and reporting.

a. Project requirements.

b. System(s).
c. System operations concept.
d. System constraints.
e. Ground systems and support.
f. Facilities.
g. Logistics.
h. Mission results analysis and reporting.

SCHEDULE & MILESTONES

RESOURCES
a. Funding Requirements.

b. Institutional Requirements (included, if appropriate)

IMPLEMENTATION APPROACH

ACQUISITION SUMMARY (included, if appropriate)

LEGAL AUTHORIZATION (included, if appropriate)

RISK MANAGEMENT
Project Risks should be addressed for the following areas: management, technical, and safety. For each risk identified, provide a description of the risk, probably impact, and planned approach to mitigation.

SAFETY
Cite the relevant safety and airworthiness requirements and documents and summarize the way in which they will be followed.

REVIEWS & REPORTING

CHAPTER 2

*A. PROJECT OFFICE **PROJECT FILE***

A project file is the responsibility of the Project Manager, and its contents vary depending on the nature of the project. However, some of the file contents are Quality Records of the Dryden Management System, so a consistent minimum set has been established. This "minimum set" must be included in the Project File. However, some projects may not need to have all of the "minimum set." The Project File may be located at the discretion of the Project Manager.

V. **MINIMUM SET OF** PROJECT OFFICE **PROJECT FILE CONTENTS**

VI. Item	Quality Record	Original
Planning Council Decision	yes	no
Small Project Authorization	yes	no
Project Plan	yes	yes
DMS Deviation Plan	yes	yes
Agreements (MOUs and MOAs)	yes	yes
Special Project Agreements	yes	yes
Approved Baseline Schedule	yes	no
Objectives and Requirements Documents	yes	yes
Flight Test Plan	yes	yes
Flight Requests	yes	yes
Configuration Management (or Control) Plan	yes	yes
Baseline Aircraft Configuration Documents	no	no
(System) Safety Plan	yes	yes
System Requirements Documents	yes	yes
Formal Design Review Completion Memos	yes	yes
RFI-s (*depends upon Config. Mgt. Plan)	no*	no
WATR Requirements Specification	yes	yes
Ground Test Plans	yes	yes

VII. Item	Quality **Record**	**Original**
Combined Systems Test Plan (or checklist)	yes	yes
Ground and Aircrew Checklists	yes	yes
Preflight and Postflight Checklists	yes	yes

VIII. TYPICAL FILE STRUCTURE

It is recommended that the Project File have a structure and that each document have a unique number. A typical structure for a Project File is as follows:

Series	File Section
A	Project Documents
B	Flight Operations
C	Taxi and Flight Test
D	Configuration Management
E	Simulation
F	Safety
G	Ground Test Plans
H	Systems
I	Instrumentation
J	Descriptive Documents
K	WATR

Chapter 3
Project Management Life Cycle

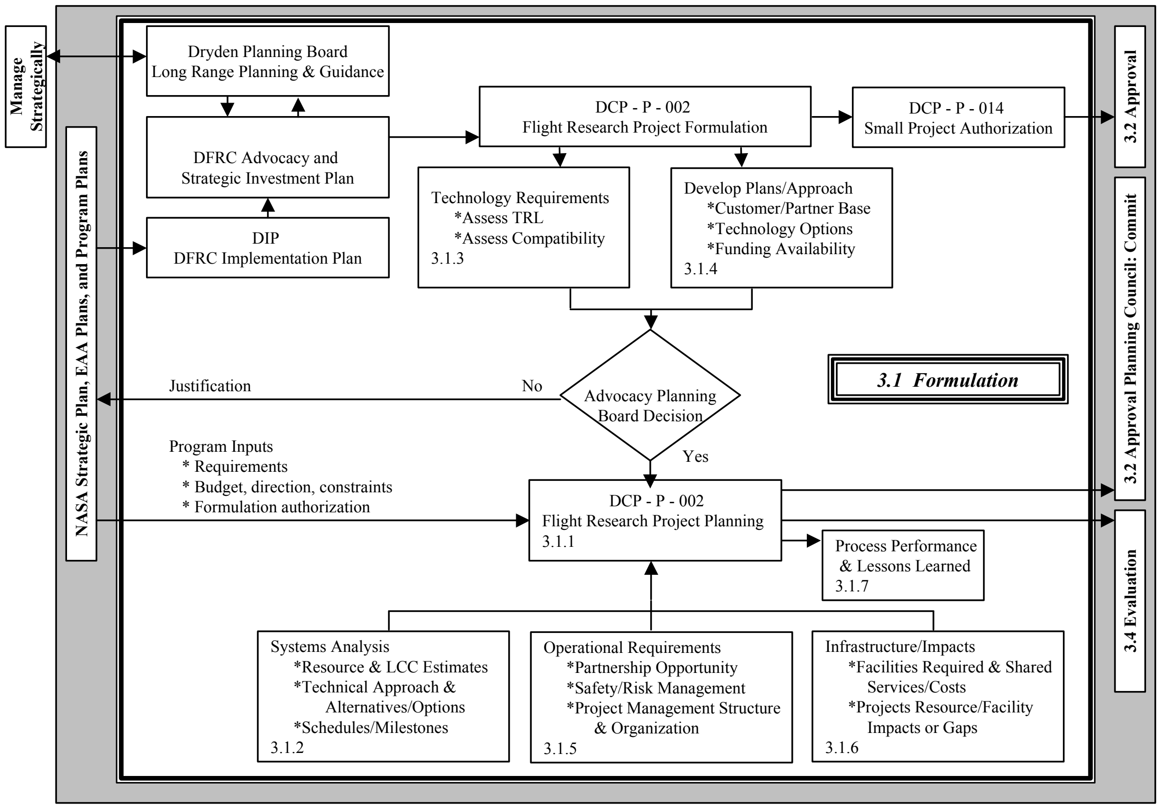
NPG 7120.5A, NASA Program and Project Management Processes and Requirements, is the guiding document for DFRC Project Management. The ISO processes developed for DFRC are integrally linked with the policies and procedures of NPG7120.5A. The DFRC project life cycle consists of four phases as described below, are linked directly to NPG 7120.5A elements, and delineated further through the referenced DCP's for each phase.

The life cycle of a project at Dryden begins with the formulation phase of the project as shown in Figure 3.1, Formulation. The process shown is functionally similar to that described in NPG 7120.5A, Figure 3-1, Project formulation sub-process.

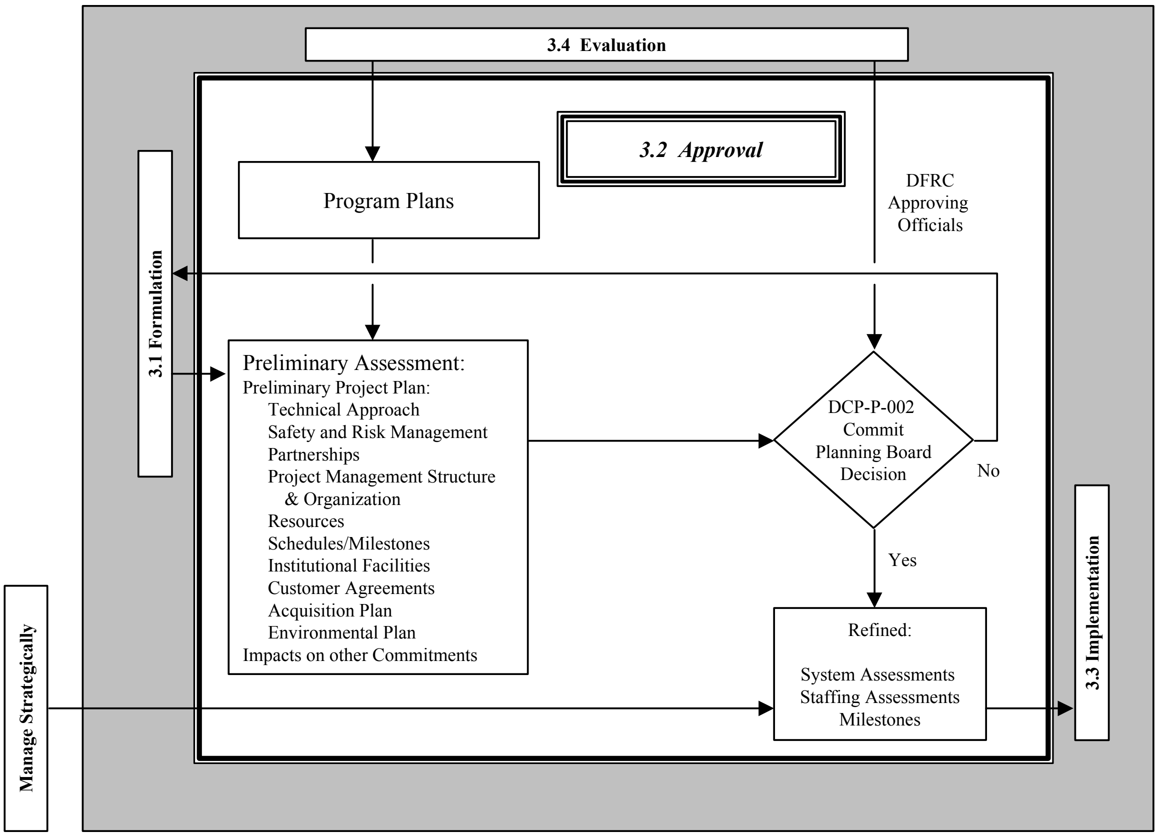
Once a project has received advocacy approval by the Dryden Planning Board, it follows the process illustrated in Figure 3.2, Approval. The process shown is functionally similar to that described in NPG 7120.5A, Figure 3-2, Project approval process. The Commit Planning Board decision is a major milestone in most projects, either issuing approval to proceed with implementation or recommending additional project formulation be completed before reconsideration.

The implementation process is shown in Figure 3.3, Implementation. The process shown is functionally similar to that described in NPG 7120.5A, Figure 3-3, Project implementation sub-process. Project implementation is the core phase of project execution, involving detailed definition of project objectives and requirements, as well as WBS and schedule, and ending with the delivery of products and services.

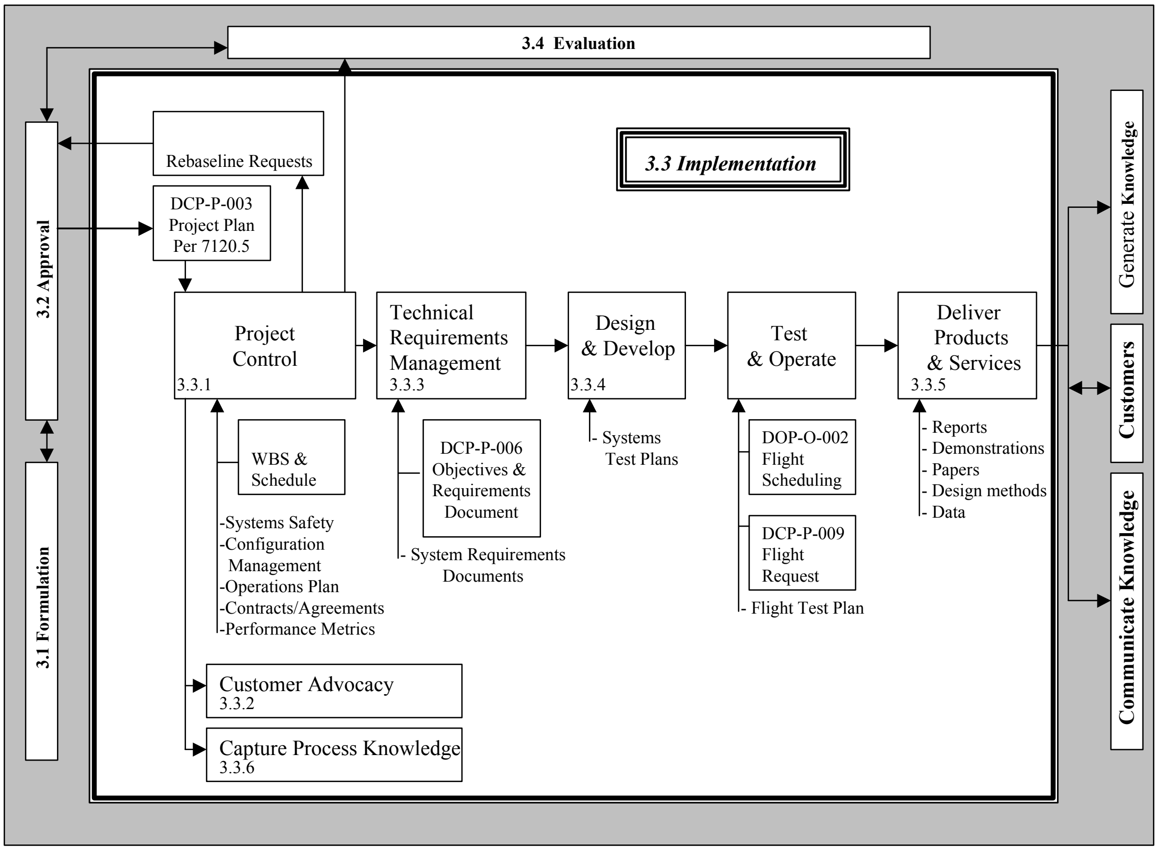
A continual process throughout the project life cycle is Evaluation, shown in Figure 3.4. The process shown is functionally similar to that described in NPG 7120.5A, Figure 3-4, Project evaluation sub-process. During the evaluation phase the project is evaluated for cost, schedule, and technical performance, including review by external customers.



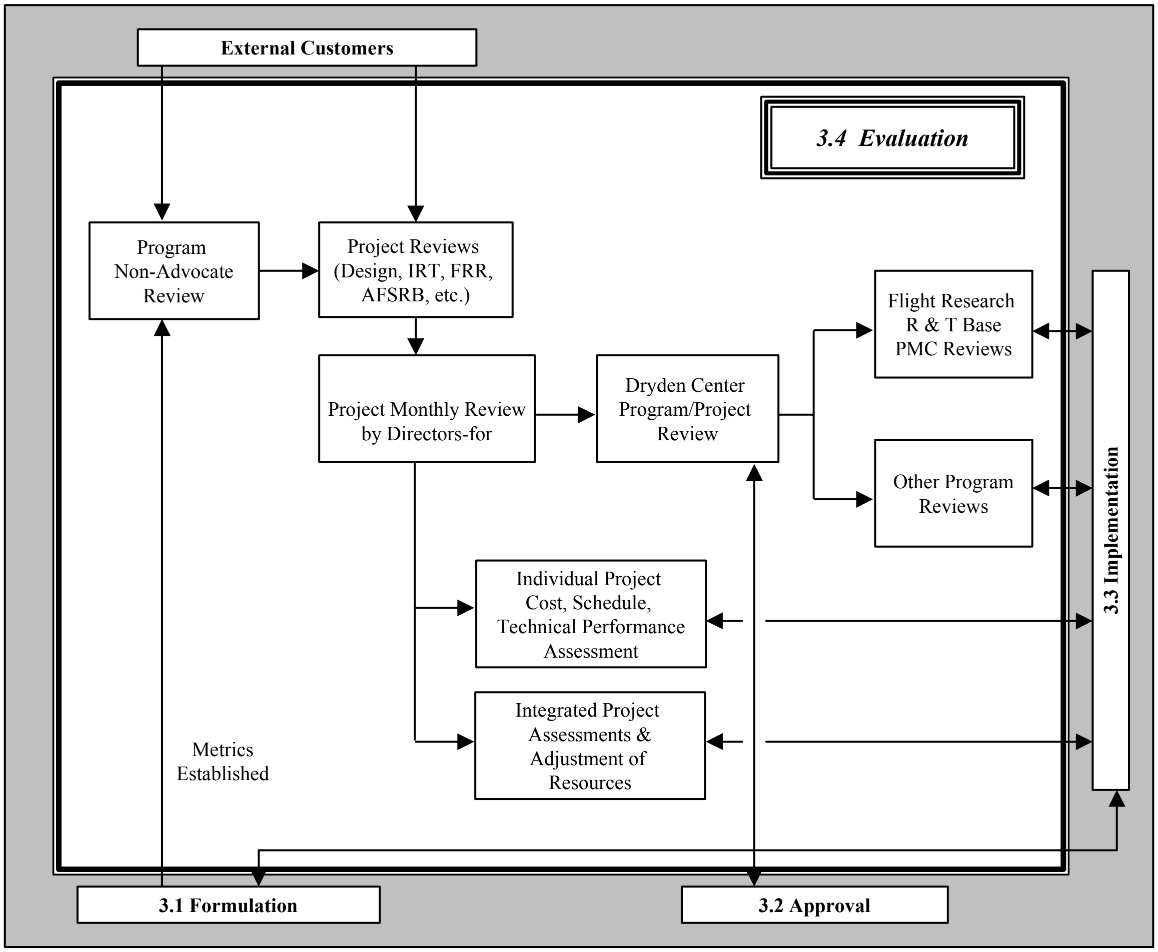
Dryden's Adaptation of the Formulation Subprocess



Dryden's Adaptation of the Approval Subprocess



Dryden's Adaptation of the Project Implementation Subprocess



Dryden's Adaptation of the Evaluation Subprocess

Chapter 4

Code P Training Matrix

The Aerospace Projects Directorate strongly supports the Agencies view that training and experience work in combination to enhance an individual's ability to perform one's job. The Directorate also supports the position that it is the supervisor's responsibility to identify training that will adequately prepare the employee to perform his/her duties in accordance with relative skill level and performance requirements. In addition the employee must take responsibility to seek and acquire training based upon his/her understanding of the job requirements and a personal assessment of one's capabilities.

To aid Project Managers and participants in NASA's Program/Project Management Development Process, Code P has developed a matrix of recommended training. This is a list of classes that illustrate the types of training, or knowledge, a Project Manager should obtain, and it is laid out in a graduated manner. As one grows in job experience, one should consider the various optional training in the list.

Two NASA sponsored courses are required in accordance with the Code P Training Template: NASA Project Management and NASA Advanced Project Management.

When a Project Manager joins Code P, the employee is asked to create a list of past training, to include the class, date taken, and sponsor. This is referred to as the Individual Training List. The Code P Training Administrator maintains this list according to DOP-P-004 and works with the employee to recommend Agency and Dryden sponsored training.

The Code P Training Matrix is provided below. R indicates "required for PMDP."

	PMDP Level			
Course Name	**L1**	**L2**	**L3**	**L4**
PROJECT/PROGRAM MANAGEMENT				
Fundamentals of PM: Tools & Techniques	R			
NASA Project Management	x	R	x	x
Overview of 7120.5A	R	R	R	R
Program Control Fundamentals	x	R		
Earned Value Management (Systems)	x	x		
S/W Acquisition Management		x	x	
Advanced Project Management			R	x
NASA Program Management				R
Multi-Project Management			x	x
International Project Management			x	x
Project Management Shared Experience Program			x	x

Technology Transfer and Commercialization			x	x
Topics In Project Management			x	x
Topics in S/W Project Management			x	x
MIP/MEP			x	x
<u>FACILITIES PROJECT MANAGEMENT</u>				
Construction of Facilities	x	x		
Construction of Facilities Best Practices			x	x
<u>FUNCTIONAL BACKGROUND</u>				
Configuration Management	x			
Program Logic and Scheduling	x			
Task Management	R	x		
Work Breakdown Structure	x	x		
Parametric Cost Estimating	x	x		
Systems Engineering	x	R	x	
Systems Requirements	x	R	x	
Project Planning and Scheduling	x	x	x	
<u>ACQUISITIONS</u>				
Procurement Processes	x	x	x	
Statement of Work	x	x		
CoTR		x	x	
Source Evaluation Board			x	x
Performance Based Contracting		x	x	x
Contract Analysis & Control			x	x
<u>SAFETY BACKGROUND</u>				
System Safety for Project Managers				
Safety & Risk Management				
System Safety in Acquisition				
NASA Continuous Risk Management	x	x	x	x
Risk Management & Fault Tree Analysis				
PDI Training Modules	x	x	x	x
Managers Safety Course				x
Mishap Prevention				x
MORT-Based Mishap Investigations				
Accident Investigation	x	x	x	x
Crew Resource Management	x	x	x	x
INTERPERSONAL SKILLS				
Leadership				

Communication				
TQM				
Interpersonal				
Negotiation				
Team Building				
<u>OTHER</u>				
Crossing Department Lines	x	x		
Lead Assessor (ISO)	x	x		
Human Element		x	x	x
Technical Short Courses	x	x	x	x
<u>DEVELOPMENT PROGRAMS</u>				
Center Level PDP	x	x	x	x
Agency Level PDP			x	x
Federal Executive Institute				
Harvard Development Program				
Simmons Middle Management Program				
SES Candidate Program			x	x
Executive Project Management Conference				x
SES Program				x

CHAPTER 5

GUIDELINES for RISK MANAGEMENT of FLIGHT RESEARCH PROJECTS

This section is not intended to be a classical safety risk management discussion, but a discussion of managing risk in general for a research, design, development, and test (RDT&E) type project. It is a collection of experiences and lessons learned that each project manager should study and understand, drawing on additional project management and systems engineering reference material. It is written in a personal style of Director, Aerospace Projects to Project Managers (PM). This chapter is intended as guidance, and the degree to which the section is applied should be tailored to each project. It should be linked to the Project Life Cycle discussion in Chapter 3.

PROJECT FORMULATION

Conceptual Studies Phase:

1. During the formulation stage of any project, the project manager (PM's) needs to weigh-in heavily with the design center in the selection of the management model to be employed through-out the life cycle. This is absolutely critical to the ability of the PM to effectively manage project risk. The management models that are currently popular are shown at figure 1. The relationship of the PM's ability to manage risk and influence overall probability of mission success is shown at figure 2.
2. During the early formulation stage PM's should cause the following data to be estimated in order to make the proper trade-offs of risks among concepts:
   - Demand that a top-level Fault Tree Analysis (FTA) be conducted and quantified (this will be rough estimates at best this early in the life cycle). It does not have to be more than five or six tiers at the point, but it essential to get the top-level technical risks understood and, just as important, to understand the relative importance and relationships of that risk.
   - Require that the top-level milestones be established showing at least six major milestones per year and the slack in schedule to each of those major milestones. The slack is the important point here.
   - Clearly estimate the costs and show the reserves by fiscal year. Understanding the reserves by fiscal year is the key to understanding whether you can handle the unknown unknowns.

   If you do not have at least these three areas estimated during the concept evaluation, you are accepting risks out of ignorance, will pay dearly for it through-out the life cycle, and it may ultimately result in program failure.

3. Once the concept is selected, you must consider at least the following elements as you move through the life cycle. This would be the minimum list from a DFRC perspective and you must draw on NPG 7120.5A and the NASA Advanced Project Management course material as you think through the life cycle. This chapter focuses primarily on vehicle reliability, and what we should demand from the Program Office and the designers.

-Mission needs/statement/analysis
-Risk assessment/program feasibility
-Draft Program Requirements Document (PRD)
  -System safety and reliability requirements should be defined early as part of PRD
  -Safety critical functions for manned systems should be two fault tolerant
  -Safety critical functions for unmanned systems that fly at DFRC and could effect the public should be single fault tolerant.

For high value (highly visibility) systems the Program Manager should consider higher levels of redundancy. NHB 1700.1 (V1-B) NASA Safety Policy and Requirements Document, paragraph 109, note 2, and the definition on page O-12 of safety critical. I have discussed this with NASA Headquarters and believe we can interpret the paragraph to mean that unmanned systems should be at least one-fault tolerant in the safety critical functions.

Note that safety critical means any event that could lead to major damage if built improperly, in addition to the severe injury interpretation.

This document has applicability to all of NASA. It is not prudent to try and enforce this requirement on vehicles that have been designed and fabricated already. However, I think we should insist on this requirement for those that are still in the early design cycle. Recognizing the intent of faster, better, cheaper, I would also stipulate that in the Systems Requirements Document (SRD) the Program Manager, with the concurrence of the Project Manager, has authority to waive this requirement. However, the waiver must be based on an assessment of the single point failures, and it show that other methods will provide reasonable reliability. Some areas such as vehicle structure and some of the propulsion fluid systems could be exempted at the outset in the SRD.

In the interest of faster, better, cheaper, I want to leave the Program Manager some flexibility, but also I want to force an informed decision on how much risk we are willing to take as an Agency at a point in the program where we still have ability to control the risk by design. Our Project Managers must be adamant about our responsibility here at DFRC to protect the public – I do not want the Flight Termination System (FTS) to be our first line of defense; we must have some level of confidence that the vehicle will perform its intended mission.

  -Severity/probability levels and acceptance criteria should be documented
  -Waiver authority should be clearly specified
-Draft systems requirements document (SRD)
  -Subsystem and part reliability requirements and allocations be specified
  -Verification requirements that clearly define protoflight vs. qualification
-FTS requirements

-Advanced technology development requirements
-Operations & logistics feasibility assessment
-Acquisition strategy

Concept Definition & Selection:

-Lifecycle cost/schedule assessment

-Requirements traceability matrix — It is extremely important (considering all the partnerships today) that we understand requirement responsibility and flow down.

-This should include a good documentation tree. Each PM must establish a documentation tree and baseline either in the Project Plan or at the CCB. It is very important that you establish a clear schedule for getting the controlling management and technical documents baselined, and include it in the detailed project schedule.

-Requirements Verification matrix — It is very important that we have at least nailed down whether the hardware/software that will be verified by analysis, test, similarity, or other before it shows up to DFRC to fly.

-There should also be a responsibility matrix that clearly shows which organization and/or person is responsible for verification of the segments of the project. Mil-Std 1540D, Product Verification Requirements for Launch, Upper Stage, and Space Vehicles provides sound guidance for developing qualification and acceptance criteria for those types of systems. X-43 project has developed a set of criteria based primarily on environments driven by the B-52. I cannot give you the exact requirement to quote, but it is essential that each project define the environment early and decide on formally documented qualification and acceptance criteria in such areas as acoustic vibration, random vibration, thermal vacuum/cycle and others. Otherwise, the project will end up at the Flight Readiness Review not understanding how the parts, subsystem, and system have been qualified and accepted hardware schemes should be specified. Clear quantitative standards for such things as acoustic vibration, random vibration, thermal vacuum/cycle, etc. for both qualification hardware and acceptance hardware need to be specified (e.g., Mil-Std 1540D)

-PM's must establish up front the qualification hardware, acceptance hardware, and protoflight hardware requirements, as well as software verification and IV&V approaches.

-NPG 7120.5A, NASA Program and Project Management Processes and Requirements clearly requires that systems analysis be conducted and functional and performance requirements be developed in the formulation phase. Our Project Managers must insist on this. This is not a nice-to-have, get-around-to-it-later event.

-System/segment specifications
-Project Plan
-Operations Requirements Document (ORD)
-DFRC needs to be the key player in defining the overall operational strategy and roles.
-Work Breakdown Structure
-Data requirements list
-Systems engineering tools and management approach — You need to decide up front how the integration will be handled — hi-fidelity simulation, combined systems/ subsystems test, energy balance analysis, etc.

-Acquisition Tool
-Finalize the items from Conceptual Studies above, or at least have very good drafts, before going into the Approval Phase.

APPROVAL

-Program Control Board (this could be the CCB) should be in place and ensure that we have reasonable fidelity in the above items before releasing the acquisition document.
-This board should have clearly decided by this time on acceptable risk levels and responsibility for risk acceptance, to include criteria for mission success, flight safety, public/range safety, ground safety (see paragraph 2 under Project Formulation).
-Configuration Control Board should be in place and ensure that the system/subsystem specifications, technical verification requirements, etc. are defined with some fidelity
-Some higher level management team in the chain of supervision should review the lifecycle assessment and risk levels

IMPLEMENTATION

Design and Development:
-Make/buy plan
-Updated ORD and Operations Plan
-Subcontract (or partners in the new scheme of things) management approach
-Configuration Item Specification
-Risk Matrix
-Preliminary Design Review (PDR)
-Regular system engineering assessments (This needs to be done for a lot of reasons, but one of particular concern to DFRC is to not allow single point failures slip into the design due to subsystem interface problems, or to allow designs that prevent us from testing the redundant path).
-Early ICD's (Too many partners waiting too long to define interfaces results in technical compromises that result in higher risk levels)

Integration, Test, and Evaluation:
-Quality inspection plan for safety critical systems must be in place
    -Test witness, etc.
    -Compliance with the standards discussed above
-Interface verification — With the partnership programs we have today this will be a problem. If the early ICD's are not done, and there is not a strong systems engineering presence throughout the life of the design/development, much retrofit and cost growth will occur.
-Redundancy testing — This should be a major concern to DFRC since the first priority for ensuring public safety should be to never get into a position of needing the FTS. Some planning has to be done in the design phase, or you will not be able to test the redundant systems except in-flight in an emergency.

-FTS inspection and test — We must demand from the outset that the FTS be able to have an end-to-end test before each flight.
-FRR — This should be organized by the AFSRB, with people from the design center and range organizations. It should be chartered to address mission success and flight, range, and ground safety. First priority should be to ensure an acceptable level of vehicle reliability, to include high confidence in the safety critical redundant systems. We do not want to be in a highly probable situation of having to use the FTS.
-Control room/Range operations — PM's need to be very disciplined about defining roles and protocol in the control room. You must enforce discipline and practice control room operations before you get to the real thing. Many of these new, high energy vehicles have very few opportunities to fly and is extremely important that PM's thoroughly script and plan control room and operations. There is no pilot to land the vehicle, fix the problem, and fly again. It has to be right the first time.

EVALUATION

Operations: DFRC involvement generally ends in the test and evaluation phase.

Reviews: The reviews are clearly described in the Dryden Management System (DMS) documentation. Do not let the "Peer Review Policies" in place today become a very poor substitute for good leadership by the PM. You cannot inspect good design and systems engineering into a project that has not been properly planned and implemented, and this is clearly the PM's responsibility.

OTHER CONSIDERATIONS:

1. Insufficient systems engineering in the formulation phase must be guarded against. It will ultimately lead to undesired compromises in cost, schedule, and performance. PM's must apply sound judgement in using analysis and modeling as a lower cost approach to systems test and validation; limiting changes to only known problems versus considering changes that contribute to mission success; driving totally to off-the-shelf hardware and inherited design when other approaches improve probability of success. Do not move into these lower cost approaches without an assessment of the technical risk.
2. Long, sustained periods of overtime must be avoided. Intangible risks will be accepted if the PM does not clearly monitor the pace and effort of the workforce.
3. Especially in the DFRC matrixed environment with many projects, PM's must guard against being one deep in key technical areas. In those technical areas of high risk, PM's must work with line organizations to find back-ups for consultation and peer discussions/reviews to drive out the best solutions. Inadequate peer interaction can be a major problem for DFRC, and PM's must work to cause that interaction. PM's must not allow a single individual to implement high risk activities without appropriate peer interaction.

4. PM's should consider using personnel from other projects, to chair or participate in subsystem reviews, especially at PDR's and CDR's. Branch chiefs should be used when possible to add that extra experience at critical review points.
5. PM's must establish, track, and verify design margins throughout development and operations. Performance indicators tied to these margins need to be developed for each technical area (see example at figure 3).
6. Verify as much by test as possible. Clearly establish at the beginning of the project the level of qualification and acceptance hardware, protoflight hardware, structural test articles, etc. You must have a clear approach from the outset. When testing cannot be employed, the simulations or other analyses, and the models to develop these, must be of high fidelity to ensure system robustness. Sufficient parametric variations in the simulations must be performed to ensure that adequate margins exists. Flight software must be subjected to complete fault-injection testing.
7. PM's must guard against program requirements not clearly delineated at the outset of the project. PM's must demand that these new requirements be funded or established requirements be descoped accordingly. Failure to do so will eventually result in compromised technical solutions to flight risk.
8. Ensure that the top-down FTA is consistently compared against the bottoms up FMEA and that the risks are clearly tracked on the hazard matrix. Closure of the hazard cannot be made until the final procedure or physical fix is accomplished. It is essential that project engineering personnel conduct the FTA and FMEA, rather than the safety office or other contracted effort, since they are the most knowledgeable of the systems.
9. DFRC is entering a new era with rocket powered, reusable space vehicles that will undergo many atmospheric tests, with high speed horizontal landings. This will present many new challenges that need to be considered in addition to the above:
   - Fly what you test/test what you fly methodology is essential
   - These maybe experimental vehicles, but testing must be sufficient to estimate safe life. The follow-on vehicles will be reusable, and it is not unlikely that the lifetime of the experimental vehicles will be extended.
   - Serious consideration should be given to establishing Mandatory Inspection Points(MIP) that require independent quality inspection sign-off. This applies to the fabrication process at other locations as well as while the vehicle is at DFRC.
     - As a sub-element to this, you must have some means to establish NASA confidence that the contractor has indeed performed the proper qualification and acceptance tests. Do not just take the word of the contractor. How will these tests be witnessed, or will you tests the components at a NASA center or integration contractor?
     - PM's must have processes in place to drive out all potential human single point failures.

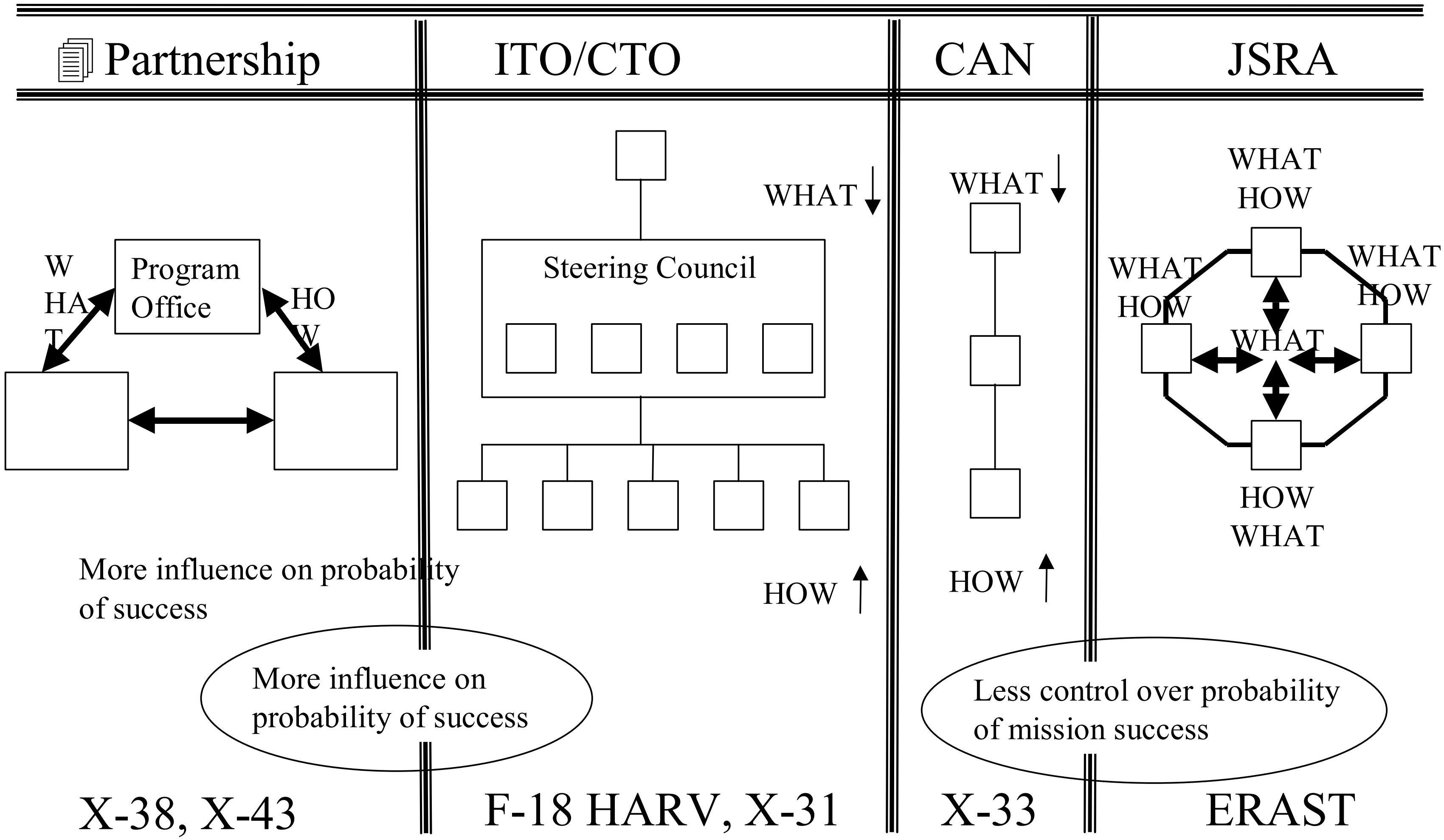


Figure 1. Management model.

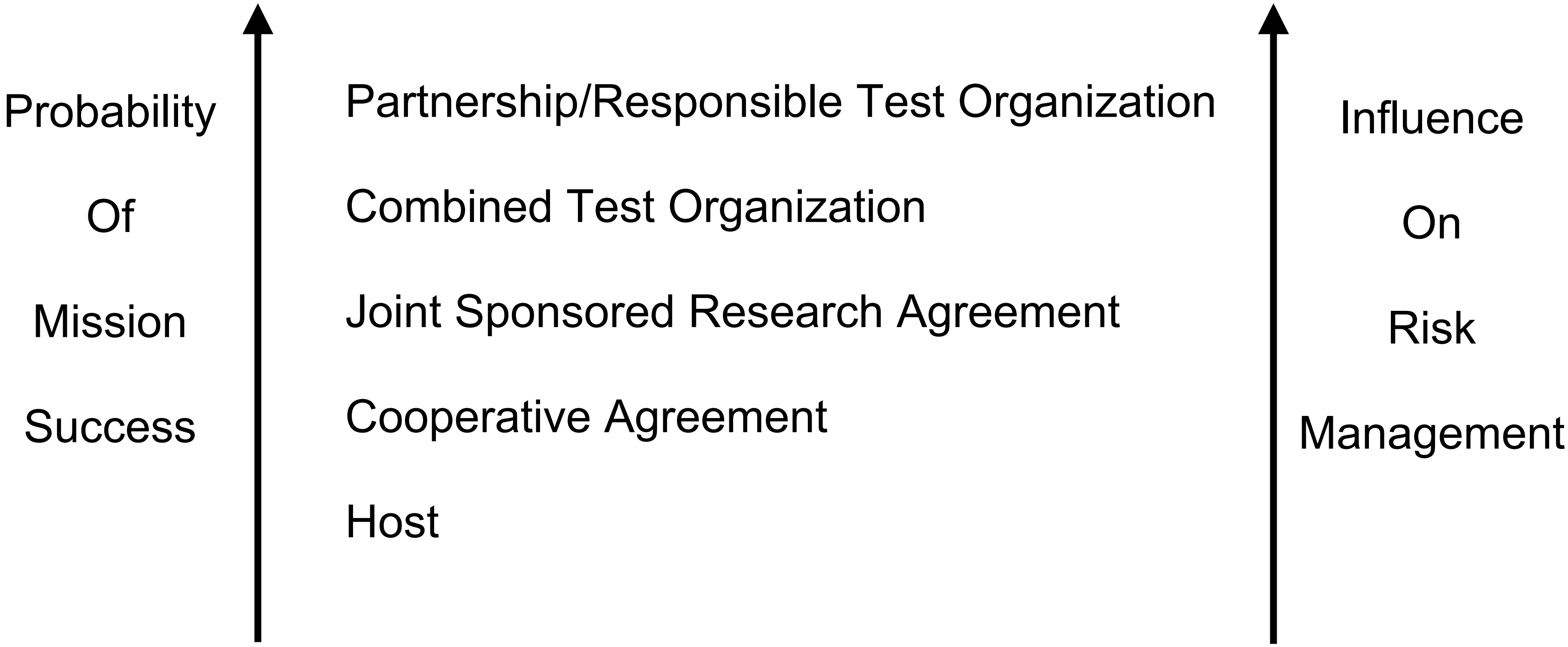


Figure 2. Management model effectiveness.

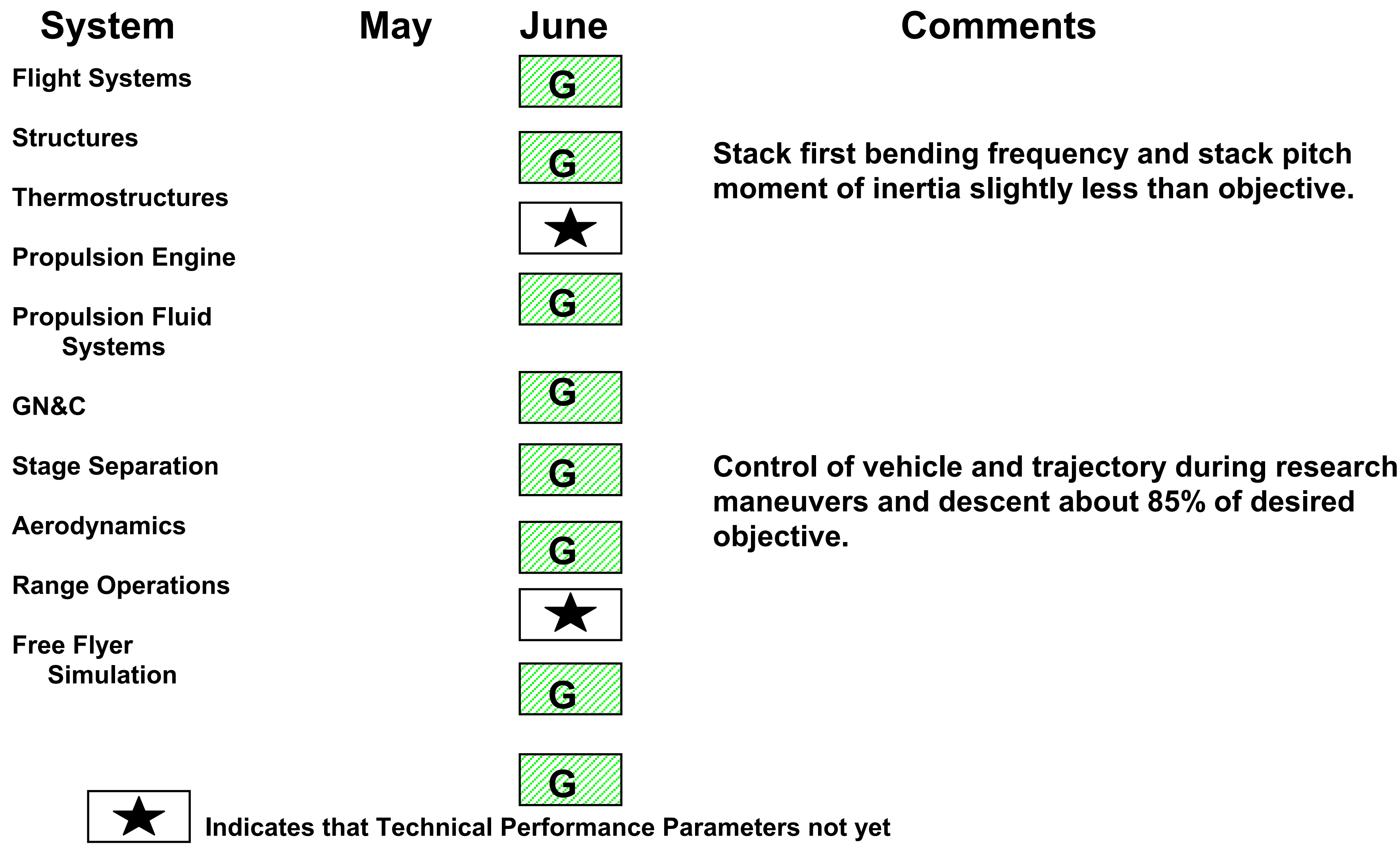
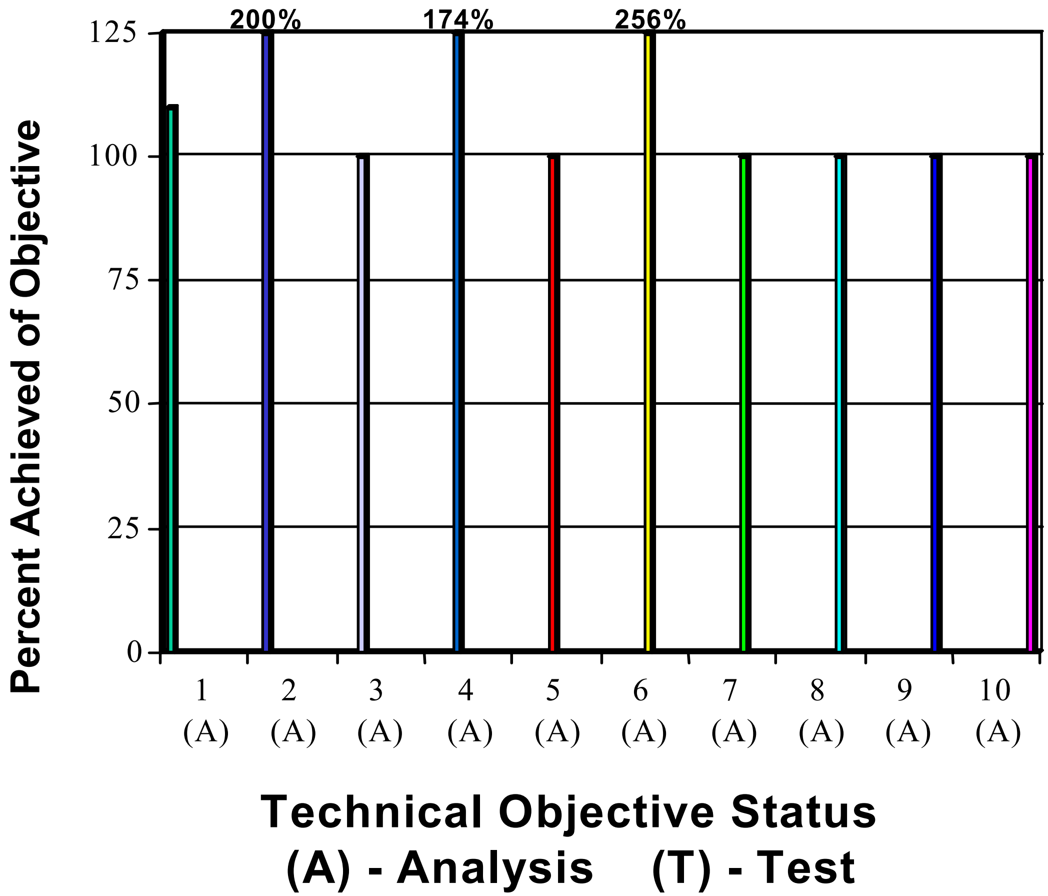


Figure 3. Technical performance assessment.



Technical Objectives

1. FMU Unused CPU Through-put > 10%, currently 11%
2. FMU Unused Memory > 20%, currently 40%
3. 28V Power System Voltage* > 24V, currently at 24V
4. 28V Energy Factor Margin > 1.0, currently at 1.74
5. 150V Power System Voltage** > 125V, currently at 125V
6. 150V Energy Factor Margin >1.0, currently at 2.56
7. Adapter sourced coolant exit pressure*** > 500psi, currently at 500psi
8. Adapter sourced coolant flow duration> 52sec., currently at 52 sec.
9. Vehicle sourced coolant exit pressure*** > 500psi, currently at 500psi
10. Vehicle sourced coolant flow duration > 36sec., currently at 36sec.

* Min. allowable voltage=24V, excluding turn on transients during the first 0.5 seconds.

** Min. allowable voltage=125V, excluding turn on transients during the first 0.5 seconds.

*** At engine coolant exit, 0.375 lbm/sec flowrate.

Figure 4. Technical performance of flight systems.

Chapter 6

Checklist for On-Site Hosted Organizations

Whenever a project has a partner (industry, university, or government), it must be assumed that they are unfamiliar with DFRC practices. The Project Manager is responsible for insuring that the new on-site organization has all of the information available at their disposal to assure mission success and safety. To that end, the following checklist may be used as a guideline. Generally, the Project Manager also hosts an introductory briefing of this information.

Host Checklist

Ask Project Manager for names of initial points of contact

Badging and Security:

- Obtain visitor badge at reception desk, ISF (N4876).
- If escorted, await arrival of your escort (phone located in lobby)
- Watch safety video shown at receptions desk (first visit)
- Obtain forms and signatures for permanent badge (if applicable).
- Obtain car registration decals from Edwards AFB Security Police office (if applicable). (Your need registration and proof of insurance)
- Obtain briefing of basic NASA and Air Force security rules (e.g., NO flightline photography).
- Information Technology security and appropriate uses of government computers and facilities (Secure ID access).

Orientation:

- Report to Dryden POC or host for orientation briefing:
- Office, hangar, shop, flightline safety and procedures
- Reporting requirements, close-call reporting
- Obtain signatures for permanent badging based on area access required, AFFTC, Area A, etc.
- Flightline driver training requirements, FOD control, flightline photography, special considerations for bldg. 1623 and AFFTC areas

- Base speed limits, gate locations and admission requirements, locations of dispensary and base hospital, food services, parking regulations
- Desert climate precautions, wildlife, and poisonous snakes, emergency telephones along Rosamond Blvd.
- Medical services available and 911 emergency calls
- Research Library, cafeteria, Credit Union, BX food court, and other NASA/AF services.
- Obtain copy of Dryden organizational chart and phone
- Book.
- Get scheduled for New Employee Orientation session (if applicable).

Hangar Regulations:

- Always check in with hangar facility representative or aircraft Crew Chief when in aircraft hanger area. See Crew Chief for briefing on hangar bay and/or aircraft safety briefing (see Hangar representative list maintained by Code OM, x3358):
  - Fueling procedures and precautions
  - Grounding procedures
  - Hydraulic and electrical connections
  - Engine run requirements
  - Tie-down provisions
  - Hangar door operation
  - HAZMAT storage
  - Emergency showers and eye wash stations
  - Location of telephones and 911 call procedures
- Check in with aircraft Chief of Maintenance for applicable aircraft/hangar/facilities rules and procedures.
- Tool crib availability and check-out procedures

HAZMAT:

- Check with your POC or host regarding HAZMAT Procedures:
  - Shipping to/from Dryden
  - Storage requirements
  - MSDS sheet inventory
  - Explosives special requirements and storage
  - Training/certification requirements for handling
  - Personal protective equipment (Code SH)
- Chemicals available at tool crib storage
- Hydrazine precautions and alarms
- All ballistics have to be routed through the Air Force Flight Test Center. See Rick Borsch in Life Support for the appropriate procedures

Flight Scheduling Process:

- Range usage
- Frequency management/frequency scheduling process
    - Working hours, Judy Duffield, x3213
    - After hours/weekends, AFFTC Command Post at (661) 277-3040
- Lakebed status
- Communications requirements with Edwards ATC
- Range control and Control Room scheduling and procedures
- Air Force Flight Test Center scheduling requirements and notifications (UAV mission worksheets, FCIF's , etc.)
- Priority assignments and conflict resolution
- Photo/Video documentation and safety
- Flight Termination System safety and scheduling process

Control Rooms and Simulation Facilities:

- Tour of simulation facilities
- Simulation training experience
- Tour of Control Rooms and WATR facilities
- Control Room procedures and etiquette
- Control Room communications and equipment training

Airworthiness Review and Approval Processes:

- FRR's, Tech Briefs, MiniTech Briefs, AFSRB's, Crew Briefs
- Flight Request form
- Mishap reporting and investigation processes

Flight Line Support:

- Contact the Maintenance Operations Office X2649 to arrange flightline support such as;
    - Ground Support Equipment (GSE)
    - Scheduling engine run areas
    - Air Force backshop support
    - Ramp usage